Summit High School
Curriculum
Science Research I
One Semester Science Elective for Grades 9-12

Revised Summer 2020 by Christine Stelmach

Course Description

Science Research I is the first course in a series or Science Research electives. These electives are designed for students who are committed to completing a long-term, independent research project. Labs, projects and literature review will be driven by student interest. Thus, each student enrolled in the Science Research electives will have a unique experience. In Science Research I students 1) compare the content, structure, and validity of peer reviewed and non peer reviewed scientific communications; 2) abstract scientific papers; 3) complete inquiry based physical science laboratory projects focusing on independent execution of laboratory procedures and interpretation of results; 4) data manipulation skills focusing on the use of Excel as a graphing tool, 5) develop presentations skills, and 6) consider areas of interest for their independent research project. At the conclusion of this course, the student will be ready to enroll in Science Research II to initiate a long-term, independent research project. Although this class is designed for 9th and 10th grade students, modifications can be made for upperclassmen enrolled in the class.

Content

Unit 1 Scientific Publications
Unit 2 Inquiry Based Research
Unit 3 Exploration of Research Topics

Unit 1: Scientific Papers

Next Generation Science Standards **HS-PS3, HS-PS4 , HS-LS2, HS-L3, HS-LS4, HS-ESS1, HS-ESS2, HS-ESS3**	
Science arguments are strengthened by multiple lines of evidence supporting a single explanation. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (HS-PS4-3) Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (HS-PS4-4) Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HSPS4-5) Science and engineering complement each other in the cycle known as research and development. (HSPS4-5)	
Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
How can journal articles be read, summarized and integrated into your knowledge base? Can all published scientific information be trusted?	Specific DCI's will be dependent on the articles read, abstracted and presented by or to the students. Articles may incorporate DCI's from Physical Science, Life Science, Earth Science and Engineering Design. Some examples of

What are the best ways to present scientific information to students, peers, professionals and the wider community?	specific DCI's typically covered in a given semester follow: **HS-PS3.B: Conservation of Energy and Energy Transfer** Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). **HS-PS4.A: Wave Properties** ● The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. (HS-PS4-1) Information can be digitized ● Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HSPS4-5) **HS-PS4.B: Electromagnetic Radiation** ● Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) ● Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. (HS-PS4-5) **HS-PS4.C: Information Technologies and Instrumentation** ● Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5) **LS1.A: Structure and Function** ● All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.

	HS-LS4.C: Adaptation ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometime **HS-ETS1.B: Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. **HS-ESS1.A: The Universe and Its Stars** ● The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HSESS1-1) **HS-ESS3.A: Natural Resources** ● Resource availability has guided the development of human society. (HS-ESS3-1) ● All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: **HS-PS4-2.** Evaluate questions about the advantages of using digital transmission and storage of information. **HS-PS4-3** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. **HS-PS4-4** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. **HS-PS4-5** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	**Instructional Focus:** ● Identify the parts of a scientific paper. Recognize that scientific papers convey information in a specific format and can be used to build a knowledge base from which the student can propose their own research. Then assess their knowledge base relative to what is needed to understand a paper. ● Compare the content, reliability, format and writing style in a peer reviewed journal article to a popular scientific article. ● Understand how one journal article links to other journal articles. ● Review the content, format and writing style of an article abstract. ● Increase knowledge base by reading, abstracting, presenting and discussing a variety of journal articles ● Use secondary sources to confirm or expand on or explain information in an article ● Review case studies on falsifying data

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems	● Recognize that there are multiple methods of conveying scientific information each with its own set of advantages and disadvantages. ● Effectively convey the results of scientific research recognizing the appropriate components of an effective presentation to target a specific audience. ● Use the appropriate visual aids for presentation enhancement. **Instructional Strategies:** ● Guided analysis of peer reviewed and non peer reviewed articles. ● Encourage students to periodically read current issues of *Science* and *Science News* and choose articles for presentations ● Each student writes an anonymous abstract ● Peer-review of student abstracts ● Instructor feedback of student abstracts ● Discuss ways to optimize a slide deck ● Model effective presentation skills demonstrated by peers ● Ask and answer challenging scientific questions related to a presentation topic **Sample Assessments:** ● Journal article abstracts ● Journal article presentations ● Peer/Instructional feedback ● Participation in literature circles **Interdisciplinary Connections** ● **ELA/Literacy: RST.9-10.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-3, HS-PS4-4) ● **ELA/Literacy: RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3, HS-PS2-6) ● **ELA/Literacy: RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-4) ● **ELA/Literacy: RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions

	with other sources of information. (HS-PS4-3, HS-PS4-4) ● **ELA/Literacy: WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6, HS-PS4-5) ● **ELA/Literacy: WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4) ● **Mathematics: MP.2** Reason abstractly and quantitatively. HS-PS4-3) **Technology Integration** ● Google Suite (Doc, Slides, Sheets, GMail etc.) **Media Literacy Integration** ● Articles from *Science*, *Science News*, *Physics Today* and other publications. ● Scientific papers have a certain form and style regardless of whether the subject area is biology, chemistry, physics or mathematics. **Global Perspectives** ● Scientific communication allows scientists from all over the world to share their knowledge constructively and increase their knowledge base. Popular media may slant scientific writing in order to increase public interest. ● Peer review is an internationally accepted process whereby scientific and technical work is reviewed and verified.

Unit 2: Inquiry Based Research

Next Generation Science Standard
HS-PS1 Matter and its interactions **HS-PS2** Motion and Stability: Forces and Interactions **HS-PS3** Energy **HS-PS4** Waves and Their Applications in Technologies for Information Transfer
Big Ideas: Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Systems can be designed to cause a desired effect. (HS-PS4-5)

Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HSPS4-5)

Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3)

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-5)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
Is there a systematic method to design, carry out and communicate the results of a scientific experiment? How is raw data secured, recorded, manipulated and shared? How can lab procedures be followed safely?	**HS-PS1.A: Structure and Properties of Matter** ● The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS2-6) **HS-PS2.B: Types of Interactions** ● Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. (HS-PS2-6) **HS-PS4.A: Wave Properties** ● Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HSPS4-5) **HS-PS4.B: Electromagnetic Radiation** ● Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (HS-PS4-3) ● When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (HS-PS4-4)

	HS-PS4.C: Information Technologies and Instrumentation ● Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. (HS-PS4-5)
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: **HS-PS4-1.** Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. **HS-PS4-3** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. **HS-PS4-4** Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. **HS-PS4-5** Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	**Instructional Focus:** ● Completion of inquiry based physical science labs that allows flexibility in experimental design. ● Recognize and safely use a variety of laboratory equipment. ● Use tables, graphs and illustrations to report and summarize data and results. ● Use Excel and other software programs to manipulate scientific data. ● Record data in a laboratory notebook. Making laboratory entries according to laboratory protocols, written or otherwise mandated. ● Understand the importance of maintaining an original record of research findings. **Instructional Strategies:** ● Review all lab safety protocols and insist that all activity is done safely ● Model a safety first behavior ● Communicate effective guidelines and modeling for a scientific notebook ● Provide lab exercise that require students to use a variety of lab equipment, enhance, modify or create procedures ● Foster a classroom community of helping, sharing ideas, experience and knowledge ● Encourage resourcefulness and independence where teacher acts as a coach **Sample Assessments:** ● Notebook check ● Excel Graphing Exercise ● Beer's Law Lab ● Speed of Light Lab ● Sun Block Lab ● Chromatography ● Project Update

	Interdisciplinary Connections ● **ELA/Literacy: RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3),(HS-PS2-6) W ● **ELA/Literacy: WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6), (HS-PS4-5) ● **ELA/Literacy: RST.9-10.8** Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-3),(HS-PS4-4) ● **ELA/Literacy: RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. HS-PS4-3),(HS-PS4-4) ● **ELA/Literacy: RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-4) ● **ELA/Literacy: RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-PS4-3),(HS-PS4-4) ● **ELA/Literacy: WHST.11-12.8** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS4-4) ● **Mathematics: MP.2** Reason abstractly and quantitatively. HS-PS4-3) ● **Mathematics: MP.4** Model with mathematics. (HS-PS4-1) ● **Mathematics: HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-3)

	Technology Integration ● Use Excel and other software programs to tabulate, graph and manipulate data. ● Use computer based laboratory probes or sensors for data collection. ● Google Suite **Media Literacy Integration** ● Use textbooks, articles and other media to enhance background knowledge, design procedures and solve problems. ● Utilize SI units in lab notebooks and scientific writing **Global Perspectives** ● In order to effectively increase the knowledge base in the scientific community, laboratory experiments must be repeatable; valid conclusions must be made from results; and the information must be shared in a systematic format with the scientific community.

Unit 3: Exploring Independent Project ideas

Next Generation Science Standard HS-ETS1 Engineering Design	
Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2) Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6) New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1, HSETS1-3) Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5) New technologies advance scientific knowledge. (HS-ESS3-5) Science knowledge is based on empirical evidence. (HS-ESS3-5)	
Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
How is the research process initiated? What are my interests? What are effective literature search and article acquisition strategies?	**HS-ETS1.A: Defining and Delimiting Engineering Problems** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to

	the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **HS-ETS1.B: Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **HS-ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS- ETS1-2)
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: **HS-ETS1-1** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-3** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	**Instructional Focus:** ● Determine interest through self-evaluation. ● Search, analyze and read the literature to find research topics or topics of interest. ● Recognize that there are multiple methods employed for locating scientific articles. ● Locate articles pertinent to a specific topic requires a strategic approach. ● Develop an effective search strategy for a specific topic. Know when to seek assistance for access to restricted articles ● Use the major internet search engines used in research. ● Narrow search parameters to adequately research a specific topic. ● Understand the inherent limitations of securing scientific articles from restricted databases. ● Consider the diverse group of

	professionals and resources in the community ● Review science fair requirements ● Consider feasibility and resources required for project completion **Instructional Strategies:** ● SHS database Search demonstration ● In class guided practice using available search engines ● Collaboration with older students on search strategies ● Discussion of possible projects with teacher and peers ● Provide examples of successful projects and encourage students to investigate the website of a variety of science fairs. **Sample Assessments:** ● Self-evaluation worksheet ● Annotated Bibliography ● Research Proposal **Interdisciplinary Connections** ● **ELA/Literacy: RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., qualitative data, video, multimedia) in order to address or solve a problem. ● **ELA/Literacy: RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. ● **ELA/Literacy: RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. ● **ELA/Literacy: RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. ● **ELA/Literacy: WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1- 2),(HS-PS1-5) ● **ELA/Literacy: SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance

	understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) ● **Mathematics: MP.2** Reason abstractly and quantitatively. **Technology Integration** Use of Internet search engines to find journal articles. **Media Literacy Integration** ● Use of Internet search engines and peer reviewed journals articles. ● Students learn what search engines are available at SHS and how to use them. ● Discuss alternative ways to access peer reviewed journals. **Global Perspectives** ● Begin the selection of a research project that will enhance the knowledge base of the global scientific community.

Curricular Addendum

Career-Ready Practices **CRP1**: Act as a responsible and contributing citizen and employee. **CRP2**: Apply appropriate academic and technical skills. **CRP3**: Attend to personal health and financial well-being. **CRP4**: Communicate clearly and effectively and with reason. **CRP5**: Consider the environmental, social and economic impacts of decisions. **CRP6**: Demonstrate creativity and innovation. **CRP7**: Employ valid and reliable research strategies. **CRP8**: Utilize critical thinking to make sense of problems and persevere in solving them. **CRP9**: Model integrity, ethical leadership and effective management. **CRP10**: Plan education and career paths aligned to personal goals. **CRP11**:. Use technology to enhance productivity. **CRP12**: Work productively in teams while using cultural global competence.	**Interdisciplinary Connections** ● Close Reading of works of art, music lyrics, videos, and advertisements ● Use Standards for Mathematical Practice and Cross-Cutting Concepts in science to support debate/inquiry across thinking processes **Technology Integration** Ongoing: ● Listen to books on CDs, Playaways, videos, or podcasts if available. ● Use document camera or overhead projector for shared reading of texts. Other: ● Use Microsoft Word, Inspiration, or SmartBoard Notebook software to write the words from their word sorts. ● Use available technology to create concept maps of unit learning.

Instructional Strategies:
Supports for English Language Learners:

Sensory Supports	Graphic Supports	Interactive Supports
Real-life objects (realia)	Charts	In pairs or partners
Manipulatives	Graphic organizers	In triads or small groups
Pictures & photographs	Tables	In a whole group
Illustrations, diagrams, & drawings	Graphs	Using cooperative group
Magazines & newspapers	Timelines	structures
Physical activities	Number lines	With the Internet (websites) or software programs
Videos & films		In the home language
Broadcasts		With mentors
Models & figures		

from https://wida.wisc.edu

Media Literacy Integration

- Use multiple forms of print media (including books, illustrations/photographs/artwork, video clips, commercials, podcasts, audiobooks, Playaways, newspapers, magazines) to practice reading and comprehension skills.

Global Perspectives

- The Global Learning Resource Library

Differentiation Strategies:

Accommodations	Interventions	Modifications
Allow for verbal responses	Multi-sensory techniques	Modified tasks/ expectations
Repeat/confirm directions	Increase task structure (e.g., directions, checks for understanding, feedback)	Differentiated materials
Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding (e.g., writing, reading aloud, answering questions in class)	Individualized assessment tools based on student need
Audio Books	Utilize prereading strategies and activities: previews, anticipatory guides, and semantic mapping	Modified assessment grading